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IoT Based Housing Area Portal with NodeMCU, Web and Android Applications

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***Abstract*—The access time of using the portal in certain blocks in a residential area can be a problem for some residents. Another problem that arises is if the officer holding the portal key is not in place. The purpose of this study is to create a system to regulate access rights to a particular block within a residential area so that the opening and closing of the portal can be done at any time by residents in the intended area. There are several blocks of this system, namely the NodeMCU controller block, ESP32CAM, Android applications, and web applications that are built using the PHP and MySQL programming languages. NodeMCU is used as the main controller to manage servo motors, send and receive data to and from the server, receive input related to open and close portals from the android application. The web application is used to register users, view the portal usage log, and verify the login process of the application. This system has been running well based on the results of tests that have been carried out, where the registration process, login, opening and closing portals, log usage is in accordance with the objectives to be achieved.**

***Index Terms*—Android; ESP32CAM; nodeMCU; portal; web application**

I. INTRODUCTION

This research explains about making hardware models, web applications, and Android applications that are intended for the use of portal systems in a residential area. Generally, the inside area of the housing uses portals on each block. The permitted access time to pass through the portal varies. It is intended for security in the area. However, there is a problem if residents in the area arrive outside the specified access time and the officer holding the portal key is not in place. Very inefficient if the occupants have to look for officers and get out of the car just to open the portal to be passed.

Other researches related to this portal have been carried out, such as research conducted in 2017 in which the gate system has been running by utilizing Bluetooth communication [1]. However, in that study, there was no log usage gate, user details, and photos of gate users at that time. Another study was conducted in 2018 where the gate security system has been running well [2]. However, in that study, there were no logs related to gate usage and no photo features related to users entering the area at that time. Other studies conducted in 2018 related to gates have also been conducted where the research system has been running well by utilizing RFID and IoT [3].

However, previous studies [1-3] were less efficient from an economic perspective. Using an RFID card costs more for both the reader and the RFID tag. In addition, there are no features related to user details, log usage, and no image capture features. Whereas in this study utilizing Android applications installed on the smartphones that are generally owned by users and providing detailed user information, user logs, and the ability to take pictures.

In general, none of the above studies have aimed at regulating access rights to a block of residential areas and there is no photo-taking feature regarding who uses the portal. So to solve this problem an automatic portal should be created where the portal can be opened at any time by the occupants by utilizing a smartphone that is owned but still pays attention to security where there is a portal usage log on the web application that contains the user's name, time of use of the portal and the actual photo posted at that time.

Regarding the flow of access to residential areas, the use of RFID cards on the portal system may be faster than the Android application. However, the advantage of the system that is designed using Android and web application is when guests come to the residential area and need access to the portal. Guests can contact the owner of the house. After that, the home owner will log in and open the portal through the application without having to go to the portal and tap the RFID card. In this process, it is still known who is logged in to open the portal and guests who come can be seen through the image capture feature. Taking pictures will be done before the portal opens. The data will be stored in the system database log. Meanwhile, if we use RFID, only cardholders can open the portal.

In principle, all residents will be registered by the head of the local RT through the web application. The head of the RT here acts as an admin. From the hardware side, there is NodeMCU which acts as the main controller of the system. NodeMCU is used to receive information related to verified users related to the login process, set the portal open and close according to the input provided by the user, give commands to take photos. Regarding the login process, there are two options for using this tool, namely by using Bluetooth connectivity or online logging in through the Android application, which will later be verified in the built web application. Bluetooth mode can be used when the user does not have an internet quota or does not get a 4G signal on the smartphone being used. NodeMCU will move the servo motor to move the portal. Closure of portal doors can be done manually or automatically. In manual mode, the user simply presses the close button on the application. In automatic mode, NodeMCU will close the portal in accordance with the input values sent from the metal detector to NodeMCU. In this study, the number of portals made is modeled as much as one.

II. METHODS

The experimental method was used in this study, where a series of experiments were directly conducted in accordance with theoretical studies. The overall block diagram of the system built is shown in Fig. 1.

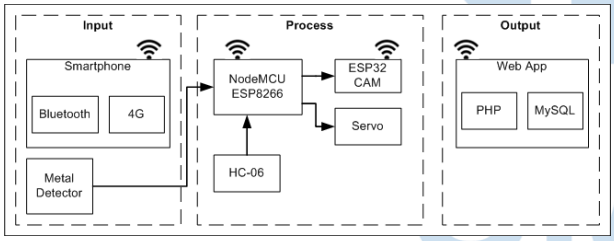

Fig. 1. Portal controller block diagram

In this system, NodeMCU is used as the main controller. NodeMCU is an open-source platform that can be used for IoT projects. In NodeMCU there is already firmware running on the ESP8266 WiFi module from the Espressive System and the hardware is based on the ESP-12E module [4]. This SoC NodeMCU ESP8266 is equipped with TCP / IP protocol that can provide access to WiFi networks,

The programming language used on the server-side is the PHP programming language. This programming language is included in the type of server-side scripting [5]. PHP can be used for a web interface [6]. In this system, the data is stored in a MySQL database. MySQL is a DBMS that is open source and is designed and optimized for web applications. Also, MySQL can be run on various platforms [7]. MySQL is also in accordance with the needs of the IoT project, which supports up to one million simultaneous users. [8]. The actuator used in this system is a servo motor where this type of motor uses a feedback mechanism to improve motor performance. To move the servo motor we can change the time of the given pulse [9]. DC servo motors usually contain a DC motor, potentio, gear, and electronic control [10]. This model uses a SG90 servo motor. PWM signal is used to control this servo motor. NodeMCU will provide a HIGH pulse of 0.5ms to move the servo motor to position 0^0 and provide a HIGH pulse of 1.5ms to move the servo motor to the 90^0 position.

The users of this system are citizens. Citizens can control the portal via online mode and Bluetooth mode. With online mode, users must log in first to be able to open and close portals. The user opens and closes the portal through the button available in the application. NodeMCU will receive commands from the server according to the input it receives via the button presses. NodeMCU will read the string from the server. If the received string is "open", then NodeMCU will move the servo motor to open the portal then give HIGH logic to ESP32CAM to take photos and send them to the server. ESP32CAM is a module that can be used to take pictures as well as a WiFi module [11]. This photo feature becomes one of the advantages of the system. The photos can be seen all back on the log page on the web.

If the user uses Bluetooth mode, then NodeMCU will receive a code format that contains the Bluetooth name and the portal open and close code. The Bluetooth module used in this system is the HC-06 module. This module is included in class 2 slave which is designed for wireless serial communication [12]. The operating voltage required by HC-06 is from 3V DC to 6V DC [13]. If the received code is an "open" string then NodeMCU will move the servo motor to open the portal then provide HIGH logic to ESP32CAM to take photos and send them to the server and send username related to users who open and close the portal at that time.

After the user passes the portal, the next process is the closing part of the portal. Closing the portal can be done automatically or manually through the button on the Android application. This built system utilizes a metal detector related to closing automatically. This metal detector is widely used for parking systems, landmine detection, and weapons detection especially in airports [14]. Metal detectors will detect nearby metals using electromagnetic induction [15]. The portal will close automatically when the NodeMCU receives input from the metal detector.

III. RESULTS AND DISCUSSION

At this stage, it was carried out between the research team and prospective respondents. Communication is carried out to obtain input features or displays that are easy to use. From the

communication results obtained by the user requirements as follows:

Fig. 2 shows the flowchart regarding the workings of NodeMCU. In this picture, it appears that NodeMCU will wait for input from the server. NodeMCU will read the response from the server. If there is a response from the server that contains the string "open" to open the portal then NodeMCU will buy ESP32CAM to take pictures and send them to the server. Next, NodeMCU will execute the command to move the servo motor to the 0-degree position. At this point, NodeMCU will continue to wait for changes in the conditions read by metal detectors. NodeMCU will wait for the metal to be detected until the condition of the metal is not approved. After no metal has been removed, NodeMCU will execute the command to close the portal and move the servo to the 90-degree position. The mode is part of closing the portal automatically.

If the received string is a user-approved "close" that is approved by the close button on the application, then NodeMCU will first discuss whether there are cars in the portal closure area by reading the metal detector. When no metal is transferred, NodeMCU will execute the command to close the portal ie move the servo to the 90-degree position. This is the part of the portal manually.

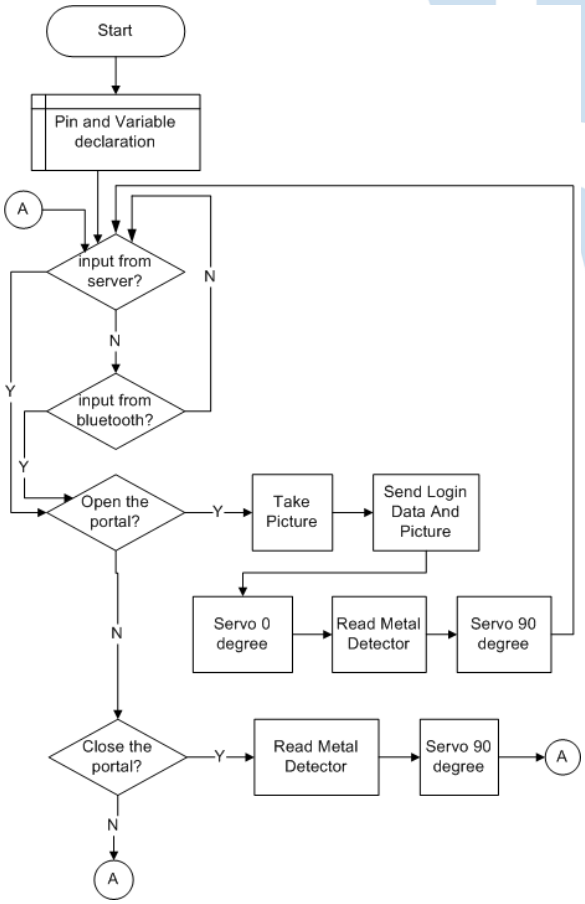

Fig. 2. NodeMCU portal controller flowchart

NodeMCU can accept input via Bluetooth in serial mode. When the user presses the open button on the Android application, the "open" string will be accepted by NodeMCU. Next, NodeMCU will instruct ESP32CAM to take pictures and send them to the server. Next, NodeMCU will execute the command to move the servo motor to the 0-degree position. At this point, NodeMCU will continue to wait for the change conditions that are read by the metal detector. NodeMCU will wait for the metal to be detected until the condition of the metal is not detected. After no metal has been detected, NodeMCU will execute the command to close the portal ie move the servo to the 90-degree position. The section is automatically closed portal mode.

When the user presses the close button on the application, NodeMCU will accept the string "close". Next, NodeMCU will check the conditions of any cars in the portal closure area by reading the conditions of the metal detector. When no metal is detected, NodeMCU will execute the command to close the portal ie move the servo to the 90-degree position. This is the portal close mode manually.

Fig. 3 shows the login screen display of the Android application that has been created. In this process, the user must enter a username and password where the password uses md5 hash encryption. On the screen, there are two usage options, namely online login to the server and Bluetooth mode. Bluetooth mode is very useful when users don't have an internet connection on their smartphones.

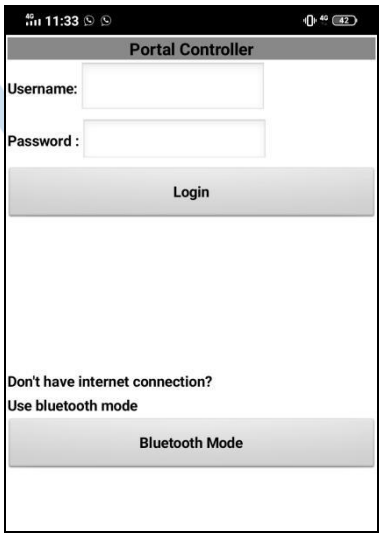

Fig. 3. Login screen android portal controller

Fig. 4 shows the screen related to the controls that can be performed by users that are opened and close the portal by online login to the server or Bluetooth mode. In Bluetooth mode, the user must enter a username and must also activate Bluetooth on the smartphone they have.

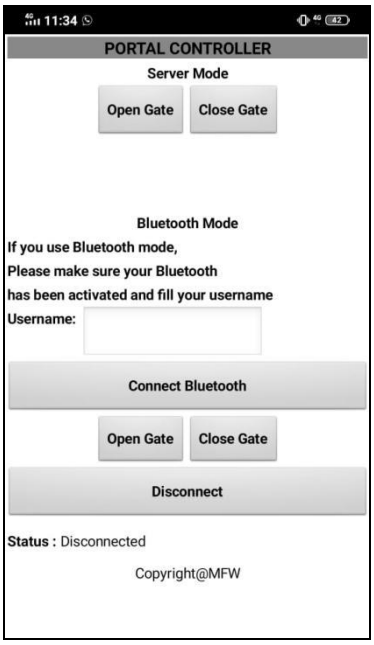

Fig. 4. Control interface android portal controller

The results of the web application that have been made are shown in Fig. 5 to Fig. 10. Fig. 5 shows the start page or index.php. On that page, users can only see the log.php page, the about_us.php page, and the contact.php page.

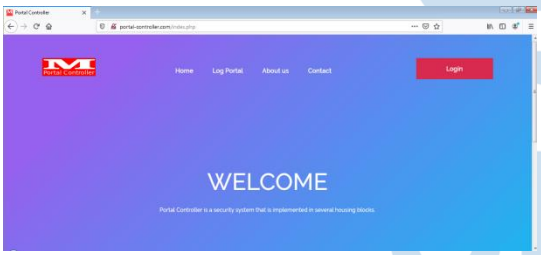

Fig. 5. Web interface index.php

In Fig. 5, you can see the "Login" button. The button is intended for Admin. When the button is pressed, a login modal will appear as shown in Fig. 6. In the modal, Admin must username and password to be able to log in. Just like the citizen user account, the admin account uses MD5 encryption in the password.

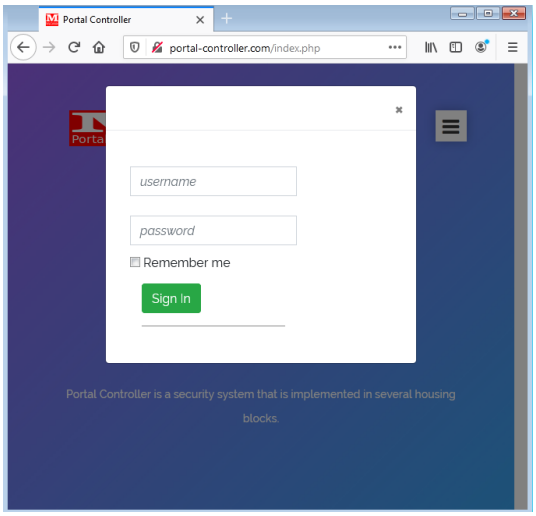

Fig. 6. Login modal for admin

When the login process is successful, the admin.php page can be seen. On that page, the admin can register new users and can see a list of users who are already registered. This admin page is shown in Fig. 7.

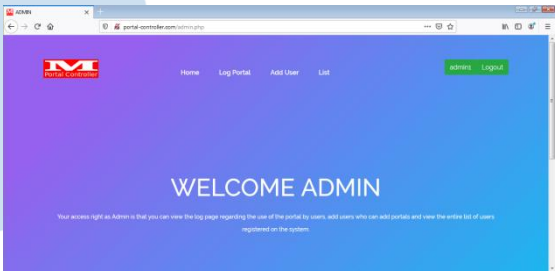

Fig. 7. Admin page

Fig. 8 shows the adduser.php page. This page is used by Admin to add new users. Some information needed for new user registration is a username, name, NIK, address, Bluetooth name, and password.

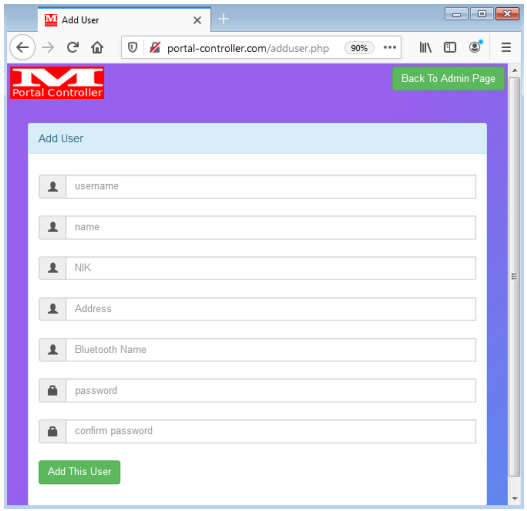

Fig. 8. Add user page

On the list.php page, the admin can see the users who have registered. Username, name, NIK, and address information are presented on that page. The list.php page is shown in Fig. 9.

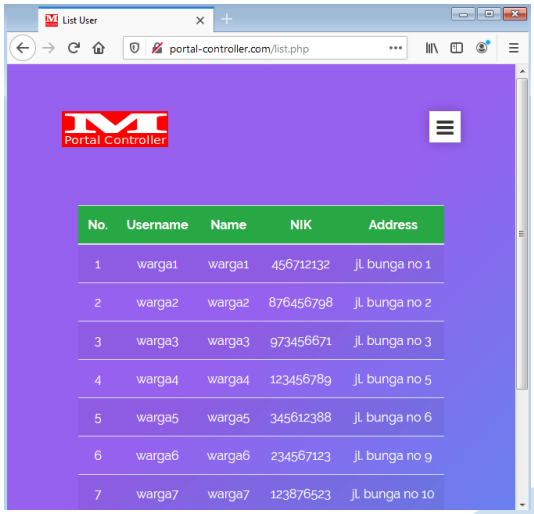

Fig. 9. Page list.php page

Fig. 10 shows the log.php page. On this page, the admin can see the portal usage log. The information presented on this page is the user's username, name, the time the portal was used, and the photos that were successfully taken. The photo in Fig. 10 shows an example of images taken from ESP32CAM that have been successfully saved on the server.

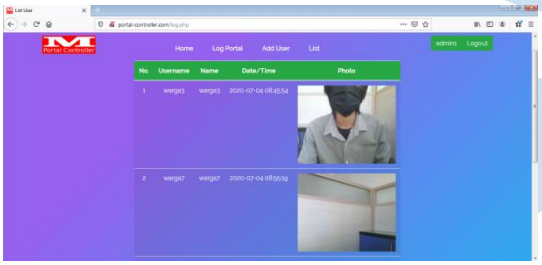

Fig. 10. Log.php page

After everything is done, the next step is testing. This test is conducted to test the performance of the system both in terms of hardware and software (Android App and Web App). Both online mode and bluetooth mode tests were carried out ten times. Each test is summarized in Table I and Table II. Table I shows the test results on a system controlled by NodeMCU where the user uses the login mode directly to the server and gives an open or close command via the Android application.

TABLE I. ONLINE MODE TESTING

Controller	Command and Action (online)		
	Received Command	*Action*	*Status*
NodeMCU	Receive String "open" from server	ESP32 CAM Take picture	OK
		Send login data and picture	OK
		Servo move to 0^0	OK
		Read Metal detector	OK
		Servo move to 90^0	OK
	Receive String "close" from server	Read Metal detector	OK
		Servo move to 90^0	OK

Based on the results of the online mode test in Table I, it can be concluded that the system works in accordance with the test scenario. The next test is carried out in Bluetooth mode. With Bluetooth mode, users can open and close portals without logging into the server. The test results in Bluetooth mode are shown in Table II.

TABLE II. BLUETOOTH MODE TESTING

Controller	Command and Action (Bluetooth mode)		
	Received Command	*Action*	*Status*
NodeMCU	Receive String "open" and username from Android app.	ESP32 CAM Take picture	OK
		Send login data and picture	OK
		Servo move to 0^0	OK
		Read Metal detector	OK
		Servo move to 90^0	OK
	Receive String "close" and username from Android app.	Read Metal detector	OK
		Servo move to 90^0	OK

Based on the results of the Bluetooth mode test in Table II, it can be concluded that the system works in accordance with the test scenario.

IV. CONCLUSION

The portal control system is working properly. Users can use online mode or Bluetooth mode to open and close portals. With this the right of access to housing can be maintained in accordance with the objectives of this study.

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